

## **$\beta$ -CAROTENE AND ASCORBIC ACID CONTENTS OF TOMATOES AS AFFECTED BY MATURITY<sup>1</sup>**

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**Abstract.** The  $\beta$ -carotene and the ascorbic acid contents of 'Walter' tomatoes were determined immediately after harvest and after ripening at 70° F for four fruit maturity stages; mature green, breaker, pink, and ripe. The  $\beta$ -carotene content increased significantly with each increase in maturity stage. Mean values for  $\beta$ -carotene in mg per 100 g fresh fruit for each harvest maturity stage were as follows: mature green-0.10, breaker-0.21, pink-0.25 and ripe-0.32. Tomatoes picked at either the green, breaker, or pink stages and ripened did not differ significantly in  $\beta$ -carotene content from tomatoes picked at the ripe stage.

Fruit harvested ripe were significantly lower in ascorbic acid than either fruit harvested at the mature green, breaker or pink stages. Ascorbic acid content decreased slightly for fruit of all harvest maturity stages after holding at 70° F for ripening. The values for ripened fruit were equal to or exceeded the ascorbic acid content of fruit harvested ripe.

Recent regulations enacted by the Food and Drug Administration allow the labeling of fresh or processed foods for nutritional composition. The U.S.D.A. Task Force on the GRAS Status of new plant varieties has stipulated that if a food plant supplies five percent or more of the mean intake of a nutrient for a significant population segment it should be monitored. Tomatoes contribute ascorbic acid and  $\beta$ -carotene at this level.

The published data on the nutritional composi-

tion of Florida-grown tomatoes is very limited and no data are available on effects of fruit maturity on  $\beta$ -carotene and ascorbic acid. The ascorbic acid content of some Florida-grown tomatoes was recently reported (6) and factors affecting the ascorbic acid content of tomatoes were reviewed.

Meredith and Purcell (9) ripened mature green 'Homestead' tomatoes at 22° C and found  $\beta$ -carotene levels that ranged from 0.12 (mature green) to 0.30 (light red) mg per 100 g fresh fruit. On 'Pearson' tomatoes Yamaguchi *et. al.* (12) found the  $\beta$ -carotene varied from 0.30 to 0.77 mg per 100 g with no significant difference due to degree of ripeness at analysis. Ellis and Hamner (2) determined the  $\beta$ -carotene content of 'Pritchard' tomatoes at different stages of ripeness to be as follows: immature green-0.17, mature green-0.18, pink-0.40, red-ripe-0.40 and over-ripe-0.37 mg per 100 g. Mature green fruit picked the same day were ripened at five different storage temperatures and fruit analysed as soon as they were red over the entire surface. Mature green fruit ripened in storage had lower levels of  $\beta$ -carotene than fruit picked at the pink or ripe stage.

Janes (4) reported the carotene content of Florida-grown 'Pan America' tomatoes to be 0.17 mg per 100 g at the green stage and 0.36 mg per 100 g at the ripe stage. The variety 'Rutgers' at the green stage had 0.17 mg per 100 g and 0.40 mg at the ripe stage.

McCollum (7) reported that mature green 'Rutgers' tomatoes ripened with illumination were higher in carotene than fruit ripened without illumination. Nettles *et. al.* (11) ripened mature green 'Grothen's Globe' tomatoes with illumination of 10 to 450 F. C, and without illumination and found no differences in the carotene content of the fruit.

The objective of this work was to determine the  $\beta$ -carotene and ascorbic acid contents of the 'Walter' tomato at the different maturity stages (mature green, breaker, pink, and ripe) immediately after harvest and after ripening at 70° F.

### **Methods and Materials**

'Walter' tomatoes were grown at the Horticulture Unit in Gainesville during the spring of 1974 on a Kanapaha fine sandy soil. Fertilizer was broadcast at the rate of 2,000 lb/acre 6-8-8 and

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Table 1. Effect of stage of maturity at harvest and of ripening following harvest on  $\beta$ -carotene content of 'Walter' tomatoes<sup>2</sup>

Maturity stage at harvest	$\beta$ -carotene (mg/100g)			
	At harvest	Ripened at 70°F		
		Breaker	Pink	Ripe
Mature green	0.10 c	0.18	0.26	0.29 a
Breaker	0.21 bc		0.32	0.36 a
Pink	0.25 ab			0.33 a
Ripe	0.32 a			

<sup>2</sup>Mean separation within columns by Duncan's multiple range test, 5% level

beds 4-feet apart were bedded up. Black polyethylene mulch was applied and seed planted in plug-mix on March 20, 1974. Fruit were harvested in the mature-green, breaker, pink and ripe stages. Three harvests were made at approximately one-week intervals starting on June 25, 1974. Harvest dates served as replications. Analyses were made for  $\beta$ -carotene using a modified AOAC method (1) by increasing sample size to 20 grams and solvent volumes 1.5 fold. The final carotene extract volume exceeded 100 ml and was concentrated in a flash evaporator at 35° C for adjustment to 100 ml. Ascorbic acid analyses were made by the 2, 6 dichloro-indophenol method (10). Starting composite sample weight was 100 g. Ten tomato fruit were sliced into wedges to prepare composite samples for the ascorbic acid and  $\beta$ -carotene analyses made in duplicate on each sample.

At each harvest, samples of fruit were placed in a 70° F, unlighted humidity controlled tomato ripening room. As soon as ten tomatoes of a single group reached the appropriate breaker, pink, or ripe stage they were analysed.

#### Results and Discussion

The average  $\beta$ -carotene content was lowest for the mature green stage (Table 1), increased for the breaker and pink stages and was highest for the ripe stage. When fruit were picked mature green and ripened, the  $\beta$ -carotene increased at each stage of maturity.  $\beta$ -carotene content nearly doubled between the green and breaker stage, increased an additional 50 percent between the breaker and pink stage and only slightly between the pink and ripe stage. Fruit harvested at the

Table 2. Effect of stage of maturity at harvest and of ripening following harvest on ascorbic acid content of 'Walter' tomatoes<sup>2</sup>

Maturity stage at harvest	Ascorbic acid (mg/100g)			
	At harvest	Ripened at 70°F		
		Breaker	Pink	Ripe
Mature green	16.7 a	14.3	14.4	15.0 c
Breaker	17.1 a		15.8	15.9 ab
Pink	17.4 a			16.5 a
Ripe	15.5 b			

<sup>2</sup>Mean separation within columns by Duncan's multiple range test, 5% level

breaker or pink stages also increased in  $\beta$ -carotene at each subsequent stage of ripening. There was no significant difference, however, in the  $\beta$ -carotene content of ripened 'Walter' tomato fruit, whether harvested at the green, breaker, pink, or ripe stages and fruit from tomatoes picked at the ripe stage.

Fruit harvested at the ripe stage were lower in ascorbic acid than either those harvested at the green, breaker or pink stages (Table 2). Ripening of fruit harvested at all stages resulted in a slight decrease in ascorbic acid content. Tomatoes ripened after picking at the mature green or breaker stage were equivalent in ascorbic acid to those picked at the ripe stage.

The U.S. Recommended Daily Allowance (RDA) for Vitamin A is 5,000 International Units (I.U.) or 3 mg's  $\beta$ -carotene. On the basis of 0.6 micrograms of B-carotene being the equivalent of one I.U. a 240 g (1 cup) serving of these ripe tomatoes would provide 1,280 I.U. (0.77 mg) or 25 percent of the RDA for  $\beta$ -carotene. The RDA for ascorbic acid is 60 mg. A one-cup serving of

the ripe 'Walter' tomato would provide 60 percent of this requirement.

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## CURING OF FLORIDA LEMONS WITH ETHEPHON

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**Abstract.** 'Bearss' lemons harvested August 13, September 18 and October 4, 1973 received standard commercial packinghouse grading and fungicides, and were subsequently treated with ethephon (Ethrel) at rates of 0, 250, 500, 1000 and

2000 ppm. The last harvest received additional treatments of 31.25, 62.5 and 125 ppm. Ethephon hastened the development of marketable color by 14 days for the first harvest, 5 days for the second harvest and 11 days for the third harvest. Tests on check fruit and that receiving 1000 and 2000 ppm ethephon resulted in 13%, 17% and 19% decay respectively following 46 days simulated marketing. Fruit color differences among ethephon rates were not apparent.

Florida lemons are harvested in midsummer when the lemon market is most active. In order to have smooth lemons of acceptable market sizes it is necessary to pick them green and "cure" them until they are acceptable bright yellow color. Because of the endemic infection with two stem end rot fungi; *Diplodia natalensis* and *Phomopsis citri* (1), ethylene degreening has been found to be undesirable due to the risk of increased decay (4, 6). Florida lemons are degreened by a process termed "curing", by holding at 15.5°C (60°F) and high (90-95% rh) humidity (3, 8). This, however, is slow, taking as long as 3 wks at the be-